PCT

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 7/38

A1

(11) International Publication Number: WO 95/12295

(43) International Publication Date: 4 May 1995 (04.05.95)

(21) International Application Number: PCT/FI94/00481

(22) International Filing Date: 25 October 1994 (25.10.94)

(30) Priority Data:
934731 26 October 1993 (26.10.93) FI

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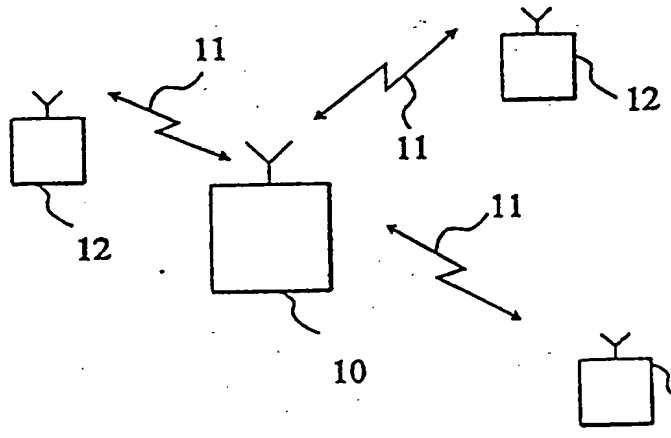
(81) Designated States: AU, CN, DE, GB, JP, NO, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.
In English translation (filed in Finnish).

(54) Title: A METHOD FOR TRANSMITTING MEASURING MESSAGES, AND A MOBILE STATION



(57) Abstract

The present invention relates to a mobile station and a method for transmitting measuring messages in a cellular radio network which comprises at least one base station (10) in each cell communicating (11) with the mobile stations (12) located in its area, and in which the mobile stations (12) measure the power level of signals received both from their own base station and the neighboring one. In order that fast measurement data transmission to the base station would be possible, the mobile station (12) compares the measured power level or a parameter calculated from it with predetermined threshold values, and if the measured power level or the parameter calculated from it reaches the predetermined threshold value, the mobile station assigns temporarily part of the capacity of the traffic channel to data transmission, and transmits data on this measurement to the base station (10) by using the traffic channel capacity.

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A method for transmitting measuring messages, and a mobile station

The present invention relates to a method for transmitting measuring messages in a cellular radio network which comprises at least one base station in each cell communicating with the mobile stations located in its area, and in which the mobile stations measure the power level of signals received both from their own base station and the neighboring one.

In a cellular radio system, the user's speech or data information between the base station and a mobile station is transmitted by means of a traffic channel. In addition to this, numerous control messages are also required between the mobile station and the base station both during call setup and the actual call. Both data on the cellular network and information on the state of the ongoing call are transmitted by means of these messages.

A cellular radio environment is characterized in that the radio connection between the base station and the mobile stations is dynamic, i.e. its quality varies constantly. This is due to variations in the propagation conditions of radio waves during a call. The location of the mobile stations with respect to the base station changes, and also in the immediate environment of the stations there may occur changes, which for instance cut off the direct line of sight between the base station and the mobile station. Therefore it is necessary for the quality of the connection to be constantly observed, in order that potential measures to improve the quality could be taken immediately, if need be.

The constant observation of the quality of the connection between the base station and the mobile

station is rendered particularly important when the changes in the propagation conditions occur quickly. This has become current especially in cities, where handovers from a base station to another have to occur quickly with the use of smaller cells.

In practice, the observation is implemented in such a manner that both the base station and the mobile station measure the signal level of the connection. The mobile station reports the measurement results to the base station controller, which decides on a handover to a new base station when the signal attenuates.

In addition to the signal of their respective base stations, the mobile stations measure generally also the signal level of the neighboring base stations in order to be able to detect when the audibility of the neighboring station is better than that of their own, and when, accordingly, it is advantageous to perform a handover. The mobile station reports also these measurement results to the base station controller.

In known cellular networks, two methods are used for transmitting control messages from a mobile station to a base station: a slow control channel and a fast control channel. The slow control channel is implemented in such a manner that a certain part of the transmission capacity of the connection is assigned to control messages. Figure 1 shows an example of the TDMA system. The figure shows a number of successive TDMA frames from the transmission of the mobile station to the base station. In addition to the traffic frames DATA, the frame SACCH, which contains control messages, is transmitted to the base station at certain intervals. For instance in the GSM system, the slow control channel is able to transmit a message at intervals of half a second. As for the fast control channel, it is implemented in such a manner that part of the traffic

channel capacity is temporarily assigned to transmitting control signals instead of speech or data information, if necessary.

In current systems, the fast control channel is used for transmitting signalling messages of the third layer of the OSI reference model in a form acknowledged through the second level (link level) between a mobile station and a base station. Call setup messages and handover commands, for instance, may constitute these messages.

The slow control channel is used for transmitting measuring messages from a mobile station to a base station in current systems. This has been practical earlier, since large cell sizes have been used, and the propagation conditions of radio waves have changed relatively slowly. It has been possible to detect the attenuation of the signal received by a mobile station in good time before the connection is broken and to establish a new connection to the next base station. With the use of smaller cells, the transmission capacity of the slow control channel will not necessarily enable the transmission of the measuring message to the base station fast enough but the connection may be broken before the handover is started.

The object of the present invention is thus to enable the transmission of the measurement results of a mobile station to a base station fast enough in order to enable a fast handover in situations where the quality of the transmission changes fast.

This is achieved with the method described in the introduction, characterized in that the mobile station compares the measured power level or a parameter calculated from it with predetermined threshold values, and if the measured power level or the parameter calculated from it deviates from the predetermined

threshold values, the mobile station assigns temporarily part of the capacity of the traffic channel to data transmission, and transmits data on this measurement to the base station via the traffic channel.

The invention also relates to a mobile station, intended to be used in a cellular radio network which comprises at least one base station in each cell communicating with the mobile stations located in its area, this mobile station comprising means for measuring the power level of signals received both from its own base station and the neighboring one. The mobile station is characterized in that it comprises means for storing threshold values for the received power levels; means for calculating a parameter dependent on the measurement result; means for comparing the power level of the measured signal or the parameter calculated from it with the predetermined threshold values; means for assigning temporarily part of the capacity of the traffic channel to measurement data transmission; and means for transmitting to the base station the data on this measurement result when the measured power level or the parameter calculated from it deviates from the predetermined threshold values.

The basic idea of the invention is thus to enable fast measurement data transmission to the base station on the traffic channel at the expense of the quality of the user's connection. The fast transmission of the measurement data enables reliable call control in the peripheral area of the cell. Accordingly, the number of calls interrupted because of unsuccessful handovers can be significantly decreased at the expense of a temporary deterioration in the quality of the call.

In the following, the invention will be described in more detail with reference to the examples of the appended drawings, in which

Figure 1 shows the already described example of the implementation of the slow control channel in the TDMA system,

Figure 2 shows a part of the cellular radio system in which the method of the invention can be applied,

Figure 3 shows an example of the application of the method in the TDMA system,

Figure 4 shows an example of a situation at a street corner in a microcellular network, and

Figure 5 illustrates the structure of the mobile station of the invention.

Figure 2 shows a part of the cellular radio system in which the method of the invention can be applied. A base station 10 is in a digital connection 11 with mobile stations 12 in its area. The method of the invention can be applied irrespective of the multiple access method used. The invention is applicable in connection with FDMA, TDMA, and CDMA multiple access methods.

In the following, the invention will be described by way of example by referring first to cellular networks using the TDMA multiple access method, and later to ones using the CDMA multiple access method, without the invention being, however, so restricted.

A mobile station thus measures constantly the strength of the signal received from the base station and reports the measurement results to the base station normally by using the slow control channel for this purpose. The mobile station stores a certain threshold value of the received power level or of the parameter calculated from it, with which the station compares the power level of the received signal. This threshold value can be set at the base station as one of the parameters of the cell. It is necessary to set the threshold value

as such that the connection will not be broken with this value, but as such that the connection is likely to be broken with values lower than that. In case the threshold has been set at too high a power value, the mobile station will use the traffic channel capacity more often than necessary, thus worsening the quality of the connection perhaps in a disturbing manner. In case the threshold has been set too low, the connection may be broken before the base station reacts to the decline in the power level by giving a handover command.

When the mobile station detects that the power level received from the base station has fallen below the predetermined threshold value, and the connection is thus in danger of being broken, the station assigns part of the capacity of the traffic channel to the transmission of measuring messages as fast as possible to the base station. In the TDMA system, this may occur in the manner shown in Figure 3.

Figure 3 shows a number of successive TDMA frames from the transmission of the mobile station to the base station. Among the frames DATA included in the actual user data, there are, at certain intervals, frames SACCH assigned to the slow control channel. In the method according to the invention, the mobile station assigns, however, one or more frames FACCH intended for user data transmission to the transmission of a measuring message. In this case, what is thus involved is a message passed through the second layer (link level) of the OSI reference model in a non-acknowledgeable form. The number of frames can vary if need be. If the power level measured by the mobile station declines fast, it may be necessary to transmit several successive messages to the base station. It is thus possible to replace one or more DATA frames by FACCH frames. The user will perceive a temporary

decrease in the quality of the speech, but on the other hand, this is a way of securing the continuation of the call by enabling a faster handover to a better base station.

The method of the invention can correspondingly be applied also in connection with the multiple access methods FDMA and CDMA. In connection with FDMA, part of the frequency band of the traffic channel can be assigned to the transmission of measuring messages. In connection with CDMA, the bit rate of the user on the traffic channel is decreased for the time during which the measuring data is transmitted, and such a bit rate is selected for transmitting the measuring data that the transmit power of the mobile station remains constant. In addition to this, the method of the invention is applicable in connection with CDMA in the same manner as in connection with TDMA, i.e. by replacing speech frames by measuring messages.

In connection with CDMA, the method of the invention is particularly advantageous, because the same frequency band is used in all cells in CDMA, and the correctly timed handover enabled by the invention minimizes the disturbance caused to the system. Figure 4 shows a situation at a street corner in a microcellular network, in which the CDMA multiple access method is used. At the street corner bordered by buildings B1-B4, there are two microcells A and B, the coverage areas of which partly overlap. The same frequency band is used in both cells. The mobile station MS is arriving from the area of the cell A to the street corner area, whereupon it observes a signal from the base station serving the cell B, which signal it perceives as a disturbance signal. Correspondingly, the transmission of the mobile station to its own base station is perceived as a disturbance signal in the area

of the cell B. In street corner situations, the changes in signal levels occur fast, so that the transmission of the mobile station MS to its own base station A, which occurs perhaps at a high power level, may be perceived as an intense disturbance in the area of the cell B.

The mobile station measures the strength of the disturbance signal, and according to a preferred embodiment of the invention, the mobile station calculates an estimate for the rate of change of the signal from the successive measurement results. The mobile station compares the measured signal level and the estimated rate of change with the corresponding threshold values, and if the signal level or the estimate deviates from the limits determined by the threshold values, the mobile station assigns part of the capacity of the traffic channel to data transmission and transmits data on the measurement concerned to the base station via the traffic channel. Accordingly, it is possible to react fast to the signal of the new base station and to minimize disturbances caused both to the mobile station and the cell B. On the basis of the information, the base station or the base station controller is able to react to the observed new base station for instance by performing a handover to the new base station.

According to a preferred embodiment of the invention, if discontinuous transmission is used in the cellular radio network for instance with speech activity authentication, the pauses produced in connection with discontinuous transmission are utilized in measurement data transmission. When the mobile station uses speech activity authentication, the station transmits user data on the traffic channel constantly only when the user is speaking. A significant number of the traffic channel

frames are thus free. These free DATA frames can be used for measurement data transmission without the user perceiving at all that the quality of the transmission deteriorates.

Figure 5 shows the structure of a mobile station of the invention. The mobile station comprises an antenna 48, a duplex filter 47, a receiver 46, a transmitter 56 and a synthesizer 49. The signal received with the antenna 48 is passed via the duplex filter to the receiver 46, after which the signal is converted in an A/D converter 45. The converted signal is applied to a detector 44, after which occurs a deinterleaving 43. The channel decoding occurs in a channel decoder 42, after which the signal is applied via a speech coder 41 to a loudspeaker 40. In the transmit direction, the signal arriving from a microphone 50 is first speech-coded 51, after which occurs a channel coding in a channel coder 52. The signal is further interleaved 53, after which occurs a burst formatting 54, from which the signal is applied to the transmitter 56 via a modulator 55, and to the antenna 48 via the duplex filter 47. The mobile station also comprises means 57 which control all the above-mentioned blocks and perform the measuring of the signal received from the base station, and possibly calculate the parameter dependent on the measurement result. The means 57 also store the power threshold values with which the measured power value or the parameter calculated from it is compared. If the measured value or parameter deviates from the limits set by the threshold values, the means 57 assign capacity from the traffic channel to measuring message transmission. The mobile station of the invention may be either a mobile phone, data terminal, or any terminal equipment functioning in a cellular radio network.

Even though the invention has been described above with reference to the examples in accordance with the appended drawings, it will be apparent that the invention is not so restricted but can be modified in various ways within the inventive concept presented in the appended claims.

Claims

1. A method for transmitting measuring messages in a cellular radio network which comprises at least one base station (10) in each cell communicating (11) with the mobile stations (12) located in its area, and in which the mobile stations (12) measure the power level of signals received both from their own base station and the neighboring one, c h a r a c t e r - i z e d in that the mobile station (12) compares the measured power level or a parameter calculated from it with predetermined threshold values, and if the measured power level or the parameter calculated from it reaches the predetermined threshold value, the mobile station assigns temporarily part of the capacity of the traffic channel to data transmission, and transmits data on this measurement to the base station (10) by using the traffic channel capacity.

2. A method according to claim 1, c h a r - a c t e r i z e d in that the parameter calculated from the measured power level represents the rate of change of the power level.

3. A method according to claim 1, c h a r - a c t e r i z e d in that the extent of the capacity assigned from the traffic channel to measurement result transmission depends on the amount of the information to be transmitted.

4. A method according to claim 1, c h a r - a c t e r i z e d in that in the TDMA cellular network, one or more data frames on the user's traffic channel are assigned to measurement data transmission.

5. A method according to claim 1, c h a r - a c t e r i z e d in that in the FDMA cellular network, part of the frequency band of the user's traffic channel is assigned to measurement data transmission.

6. A method according to claim 1, characterized in that in the CDMA cellular network, the bit rate of the user's speech or data signal on the traffic channel is decreased for the time during which the measuring data is transmitted, and such a bit rate is selected for transmitting the measuring data that the transmit power of the mobile station remains constant.

7. A method according to claim 1, characterized in that in the CDMA cellular network, one or more data frames on the user's traffic channel are assigned to measurement data transmission.

8. A method according to claim 1, characterized in that when discontinuous transmission is used in connection with speech activity authentication, measurement data is transmitted on the traffic channel when speech is not transmitted.

9. A method according to claim 1, characterized in that the data on the threshold value with which the measured power levels are compared is transmitted to the mobile station (12) from the base station (10).

10. A mobile station, intended to be used in a cellular radio network which comprises at least one base station (10) in each cell communicating with the mobile stations (12) located in its area, which mobile station (12) comprises means (57) for measuring the power level of signals received both from its own base station and the neighboring one, characterized in that the mobile station comprises means (57) for storing threshold values for the received power levels; means (57) for calculating a parameter dependent on the measurement result; means (57) for comparing the power level of the measured signal or the parameter calculated from it with the predetermined threshold values; means (57) for assigning temporarily part of the

capacity of the traffic channel to measurement data transmission; and means (57) for transmitting to the base station the data on this measurement result when the measured power level or the parameter calculated from it reaches the predetermined threshold value.

11. A mobile station according to claim 10, c h a r a c t e r i z e d in that the parameter calculated from the measured power level by the means (57) represents the rate of change of the power level.

SACCH	DATA	DATA	DATA	DATA	DATA	SACCH	

FIG. 1

SACCH	DATA	DATA	FACCH	DATA	DATA	SACCH	

FIG. 3

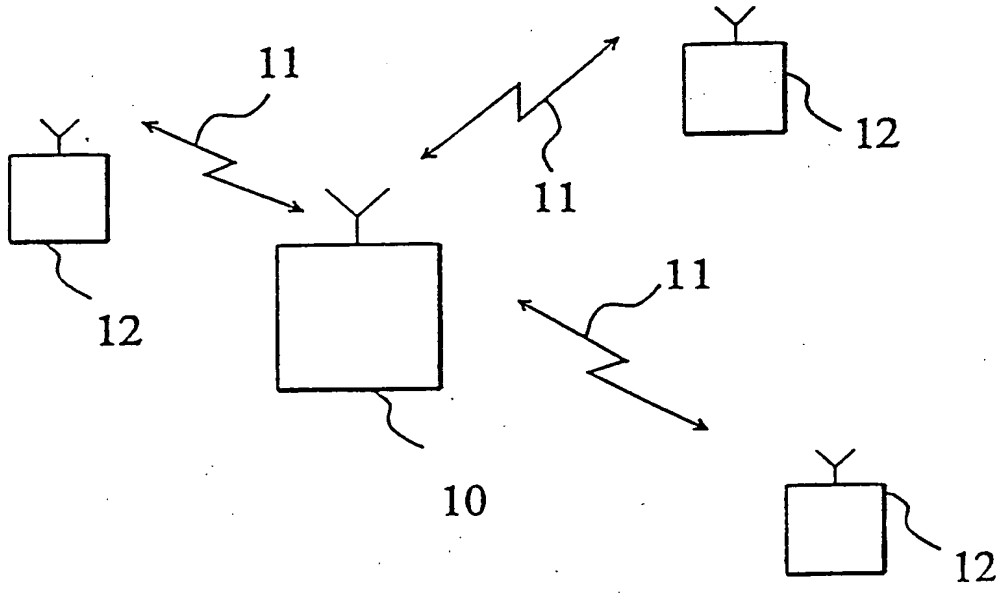

FIG. 2

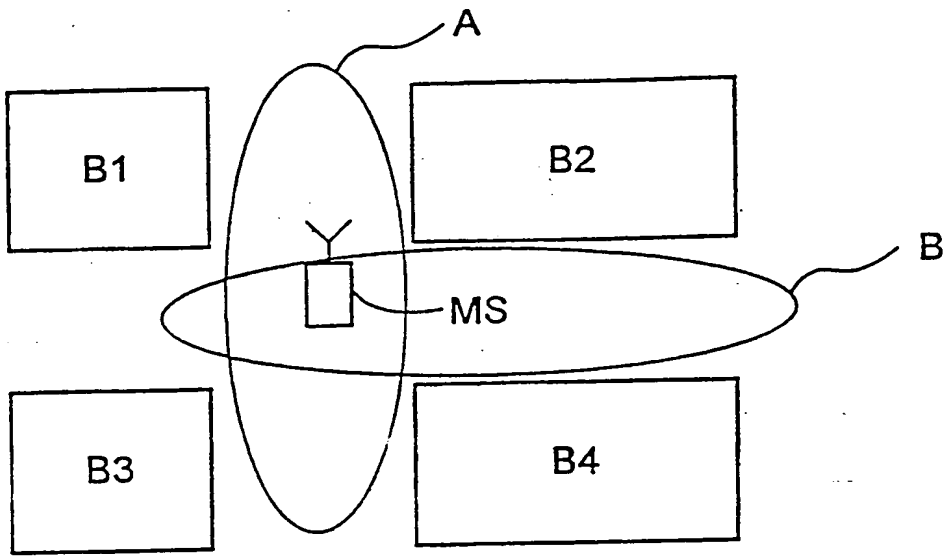

FIG. 4

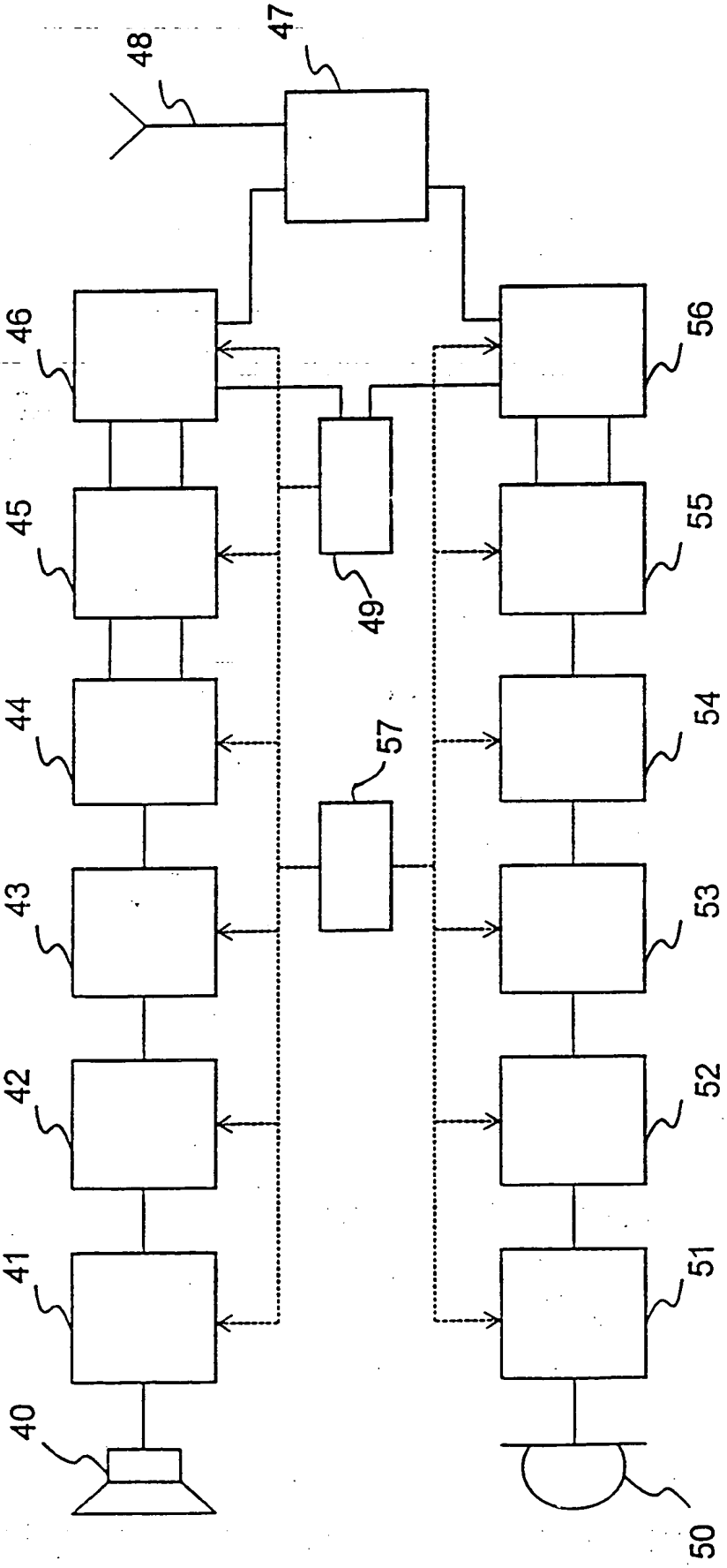

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 94/00481

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP, A2, 0566551 (TELEFONAKTIEBOLAGET L M ERICSSON), 20 October 1993 (20.10.93), column 6, line 4 - line 20; column 8, line 47 - column 9, line 20	1,3,6-10
Y	EP, A2, 0241954 (PHILIPS PATENTVERWALTUNG GMBH), 21 October 1987 (21.10.87), column 7, line 42 - column 8, line 4; column 9, line 15 - line 34	1,3,6-10
A	WO, A1, 9212602 (BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY), 23 July 1992 (23.07.92), page 8, line 27 - page 9, line 9	2,11

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search
17 March 1995

Date of mailing of the international search report
20 -03- 1995

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 94/00481

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

09/02/95

International application No.
PCT/FI 94/00481

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		DE-D-	3787916	00/00/00
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